1750 METERS: WESTERN UPDATE #60

THE WESTERN NEWSLETTER FOR THE EXPERIMENTER'S BAND (160 TO 190 KHZ)

Available for business-size 25 cent SASE's, plus 60 cents per issue (or $7 per year)
from: Jim Ericson, 226 Charles St., Sunnyvale, CA 94086-6063

ACTIVE WESTERN LowFER BEACON STATUS (LIST COMPILED November 6, 1988)

FREQ(kHz)	IDENT	QTH	SKED INFO
✓ 163.39	T	Sunnyvale, CA	24h/7d. A2, +/-775 Hz modulation.
163.80	FPV	Granada Hills, CA	24h/7d. See alt. freq. 182.62 kHz.
163.85	M	San Diego CA	Testing sometimes.
✓ 164.00++	JKS	San Anselmo, CA	Freq. Hopping (164, 165, 166, 167 kHz)
✓✓ 165.015	TLX	Novato, CA	24h/7d. Note QSY.
✓✓ 165.656	ZY	9 mi. NW of San Simeon, CA	By request. New beacon at old SKY site.
✓ 166.503	C	near Morro Bay, CA	24h/7d.
166.667	H	Descanso, CA	24h/7d.
167.25	AHN	Fallbrook, CA	24h/7d.
169.863	1SUN	Durant, OK	Schedule unknown.
170.39	B	San Ysidro, CA	24h/7d xtal. Previously was XU.
175.225	MAX	Wheatland, WY	24h/7d CW. BPSK/ASCII by request.
175.703	FAW	Orem, UT	24h/7d.
176.00	HDOMBAY	Morro Bay	24h/7d.
176.26	C O	Glenwood Springs, CO	24h/7d.
176.75	SR	Elgin, OR	24h/7d.
176.85	7FS	Belfair, WA	24h/7d. Back on the air.
✓ 177.49	UCP	Saratoga, CA	Daily, approx. 1400 to 1700 UTC.
178.00	AT	Crow, OR	Status unknown
179.0	MPM	Salt Lake City, UT	24h/7d. ASCII/CW alternating 5minutes.
180.224	F	Los Banos, CA	FSK. By request.
180.70	NRE	San Diego, CA	24h/7d.
181.17	IZJ	San Gabriel, CA	Daily. Silent 0700 to 1100 UTC.
✓ 181.287	MEL	San Jose, CA	24h/7d.
182.62	FPV	Granada Hills, CA	24h/7d. See alt. freq. 163.80 kHz.
✓ 182.672	G	Palo Alto, CA	24h/7d.
✓✓ 182.88	H2	Descanso, CA	24h/7d.
✓ 183.160	PRK	Saratoga, CA	24h/7d.
183.63	PLI	Toluca Lake, CA	24h/7d.
183.95	8 dits	Palo Alto, CA	Intermittent tests. Same QTH as "G".
184.016	EK	Sunnyvale, CA	24h/7d.
184.32	N3S	Mocksville, NC	Intermittent tests.
✓ 184.43	V	Forestville, CA	24h/7d.
185.0	ZYK	Redway, CA	Sked unknown.
✓ 185.08	TMT	San Rafael, CA	24h/7d. Previous idents were ER and EDN.
185.49	AZ	Tucson, AZ	24h/7d.
186.80	BA	Lancaster, IL	24h/7d.
187.0	ELU	Simi Valley, CA	24h Saturday and Sunday on SSB.
187.252	TEXAS	NW of Ft. Worth, TX	24h/7d.
187.30	UPN	Cincinatti, OH	Occasional.
187.50	DCH	Berlin, MD	24h/7d.
✓✓ 187.59	SM	San Jose, CA	24h/7d. Note slight QSY.
✓✓ 189.84	R	Nevada Test Site	24h/7d. Previous ident was NTS.
190.4	OHH	Richmond Hill, Canada	Occasional testing.
514.127	U	9 mi. NW San Simeon, CA	24h/7d. Mike Mideke.
✓✓ 522.62	SA	San Rafael, CA	24h/7d. Steve McGreevy.
✓✓ 530.+/-.76	T	Sunnyvale, CA (WA6AJY), A2 mod	24h/7d. Ed Gelinas. Simulcast with T at 163.39kHz.
✓✓ 1637.44	ER	San Rafael, CA	24h/7d. Steve McGreevy.

4 MORE SASES ON FILE

(Check means sig logged at EK QTH in September/October/November. Double check is QSO with EK. Non-Western listings are beacons currently being copied in the West, or they have SASE's on file with us. The four MF beacons at the end of the list are shown for interest, since they are operated by LowFERS...and they ARE getting out!).

MAILBAG: **Charles Faulkner (FPV)** writes from Southern California, "We (**PLI, FPV, ELU**) still maintain our sked on Saturday mornings at 9am. We use SSB, RTTY, Amtor, and packet. I prefer the Amtor -- seems to work better in the noise." **Clint Turner** writes, "Dropping you a line to inform you that after October 15th, **CT** will QRT indefinitely Will give details later." **Gary Waldsmith** of ElDorado Hills, CA sent along a copy of the September 1988 **QEX** magazine which had some news on page 12 concerning the Space and Naval Warfare Systems Command (**SPAWAR**) LF antenna tests. Testing will be conducted near 175 and 185 kHz using 1kW into a triangle loop 65 feet high and 400 feet on the base! Locations will include Virginia and Maryland. Although this testing was scheduled for August to October, we understand there have been some delays. Current information on the test times and exact frequencies are provided by a pre-recorded message available by calling (703) 471-1539. **Bob Cutter** checked in to report that he just completed the fall "tune up" on his **CO** beacon in Colorado. **Al Taylor** writes from Whitehorn, CA, "The WU articles by **Max Carter** and **Mark Mallory** are great! I appreciate their taking time to explain the terms and theory. Keep up the good work. I'll be on the air with **SC** (for Shelter Cove) on 175.000 kHz as soon as I get the antenna up. I am a retired Mechanical Engineer from Lawrence Livermore Lab and looking for a challenge, took up ham radio at the age of 63 (I just turned 65)." **Rick Joslin** (WB5VUL) of the local 2m emergency group called **SPECS** notes that the new ZIP+4 format enables the Post Office to lessen the time to process a piece of mail. Automatic sorters can route it further with the extra four digits. Note that I've added the extra digits to my address. Check yours and send me the extra digits when they become available. **Keith Olson** (**7FS**) reports hearing **MS** on 187.8 kHz at 0640Z October 5th. MS was sending either slow dots or dashes. Keith says, "The MS ran together so sometimes it sounded like 7." **Jay Coote** (J) of Los Angeles reports, "I have been hearing an unlisted beacon **ZIR** at about 178.7 kHz. The format is CW, one ident about every 5 seconds. Also heard **PLI**'s AMTOR signals recently in the LA area. Don't have a PK232 yet, but I am glad LowFERS are working on keyboard/digital communications. Maybe someday we'll see a standard digital mode of LowFER communications with digipeating, mailboxing, and other features found in Packet -- at a slower baud rate of course!. Your readers might be interested to know that **ALL ELECTRONICS**, POB 567, Van Nuys, CA 91408 has IRF 511 hexfets for $1 each or ten for $9." Jay asks if anyone has ideas for concerting a Burhans loop preamp to work with a shielded 12-inch ferrite loopstick? His proposed application is mobile RDF'ing at LF/VLF. On the subject of transmitter efficiency, Jay adds, "What might win me over to the filter-less switching transmitters as seen in the last few WU's would be knowing that the following could be achieved: 1. Matching to unknown antennas between 10 - 200 ohms by tapping the tank coil without losses in efficiency. 2. Adjusting the tank tap or resonance for legal input power at the higher voltages hexfets work best at -- without loss of efficiency. 3. Demonstration of an accurate method for RF power measurement. This is an important area since the unfiltered waveforms we are talking about may not be easy to measure with conventional methods. 4. A little more testing of how well the antenna coil in these circuits attenuates harmonics -- for those of us whose neighbors attribute vehicle and appliance failures to each new antenna that sprouts in our yards" **Todd Roberts** (ABC) says, "I have really enjoyed the articles on transmitter efficiency and will give a solid-state rig a try. Up till now I have been pretty well sold on tubes for 1750M transmitting, hi!" **Brice Anderson** (BA of Illinois) announces, "I continue to hear **TH, WI, UPN**, and am now hearing **9HDQ** and **KRY**. There was no let up of DX during the summer months! I have most of my ground radial system down again. It will be difficult to mow the yard now. I haven't heard **VE3OHH** (LF) yet, but am trying." **John Leonardelli** of Ontario wrote to update his callsign and phone number and commented, "I am now in an apartment and my only salvation is the LF Engineering L-400B. I seem to have overloading problems with my Burhans whip, but am continuing to experiment." **Scott Hedspeth** of North Carolina says, "Beacon **N3S** on intermittent test. Running behind schedule. Still 184.32 kHz. Using IRF 511 into a 30 foot vertical." **Rick Nickerson** of Sacramento called on the phone 11/3 to report hearing our **EK** beacon during the daytime. Distance is about 90 miles. **John Seamons** (JKS) surfaced in San Anselmo, CA after being overwhelmed with a huge computer project at work for several months. John reports, "**JKS** is back on the air frequency hopping at 164, 165, 166, and 167 kHz synchronized to WWV. I moved so that **Sheldon Remington** might have a better shot at it from Hawaii." **Bill Hooper** of Los Altos, CA reports hearing **MPM, MEL, TLX, PRK, EK, SM**, and **PLI** from his remote listening location at Webber Lake, 25 miles north of Truckee, CA. Bill is using a 1000 foot longwire into a homebrew regen pre-amp, an LF Engineering 101 converter, a Magnavox D2935 receiver, and a MFJ 752C audio filter. Bill's remote site is at 7000 feet, and is quiet. He says, "I intend to put up a beacon and try some 2-way QSO's in the spring when the snow melts."

ZEBRA NEWS FOR WU*60 - by: Mike Mideke, PO Box 123, San Simeon, CA 93452. October 23rd - Within a week of its arrival, the front page of my WU*59 was covered with additions and revisions to the active list. This is a sure sign of a busy fall/winter season ahead - surely the most active 1750M season to date.

REPORTS: LowFER beacons first heard in September and October include:

SA 522.62 kHz 9/29. **R 189.84 kHz** 10/17. **SK** (carrier 189 khz, many sidebands above and below) 9/6. **ER 185.13 kHz** 9/29. **EDN 185.08 kHz** 10/19. **V 184.43** kHz 9/19. **Long Dash** 164.17 and 161.6 kHz (sidebands of 163.4 kHz) 10/22. Nightime skywave in October: **MPM, FAW, 7FS.** Daytime skywave: Traces of **MPM** on 10/18.

An unexpected weekend off from ranch chores allowed me to get the new antenna up at the **SKY** site. For the time being, ident is **ZV** and frequency is 165.66 kHz. Operation will be by request (contact me or **EK**). Ident, frequency and transmission mode subject to change without notice. I'm really not in the 1750M beacon business anymore but I DO have a 24 hour 7 day beacon up at the old **Z2** site. It signs "**U**" on 514.127 kHz and has demonstrated copyable groundwave beyond 25 miles. Since this frequency segment is quiet and interference free by comparison with 1750 M, there really is a possibility of skywave copy. I am hearing Steve McGreevy's 89 milliwatt **SA (522.62 kHz)** about every other night at 160 miles. Just brief fade peaks squeaking through, but when the signal is up it is nice. Bandwidths less than 100 Hz, hot receiving antennas and quiet listening sites are virtually essential!

RFI NOTES: It is relatively easy to bring 1750M transmitters to conformity with the FCC regulations on harmonics and spurs (all out-of-band products at least 20 dB down from the fundamental). For Part 15 transmissions, this is adequate to protect the radionavigation service (NDB's). However, much greater attenuation may be required to eliminate other interference problems. The real requirements depend on what is happening in the area of the transmitter.

Those of us who do weak signal work on higher frequencies must often go to great lengths in filtering and trapping beacon harmonics. And of course we should try to keep the neighbors happy. 1750M transmitters are quite capable of clobbering the AM BCB, Citizens Band, TV, and other services.

If you rely on your high-Q loading coil to clean up the signal, do remember that at upper HF and VHF frequencies the distributed capacitance of the coil will effectively bypass the inductance, giving any residual harmonic energy a free trip to the antenna. Admittedly there should be little such energy present in our signals...but at those higher frequencies it does not take much to cause problems. Don't neglect the possibility of low level radiation from exciters, synthesizers and the like.

Another potential problem is fundamental overload from the intense and relatively near-field surrounding our short loaded antennas. This can do nasty things to the front ends and AGC systems of BCB and shortwave receivers. It can make problems with audio systems, intercoms and telephones. Best answer is to get the transmitting antenna as far as possible from anything that might be affected and then deal with any remaining difficulties case by case. Good grounds help too!

73 - mike

October 15, 1988

Mr. Jim Ericson
226 Charles St.
Sunnyvale, CA 94086

Dear Jim,

I have just one final comment concerning the Lowfer transmitter efficiency debate. Max Carter's idea of driving the antenna circuit with square waves may certainly result in high power efficiency but unless the Q of the antenna/loading coil circuit is very high, harmonic radiation will be very efficient also. One must keep in mind that the antenna radiation resistance goes up with the harmonic number, thus making the antenna much more efficient at radiating any harmonics that may be present than the fundamental. A pi-network between the square wave generator and the antenna circuit should suffice in presenting a resonably good sine wave to the antenna with minimal harmonics. I feel that it is imperative that the signal driving the antenna circuit should be sinusoidal even if efficiency must be sacrificed.

On another subject I have been experimenting with a portable Lowfer receiver/antenna combination that seems to perform very well. The antenna is an LF Engineering L-400B active antenna which has far exceeded my expectations and is highly recommended for any low frequency applications. When mounted 8 feet or higher in the clear (and I mean in the clear!) it has outperformed long wires up to about 750 feet. I must warn about the intermodulation problems, however, if the antenna is near high power broadcast transmitters. This can be improved somewhat by reducing the coupling to the receiver.

The portable receiver is a modified Radio Shack DX-440. Without the modifications the receiver is essentially useless on longwave except for GWEN reception and this is marginal. The modifications involve adding about 10 turns of wire around the internal ferrite loopstick in order to inject the signal from the active antenna. In addition, a .001 uf capacitor should be soldered across the original loopstick winding to resonate the rod to the middle of the Lowfer band. I have found that the combined system makes an excellent highly portable longwave receiving system. The selectivity leaves something to be desired but I will soon be adding the HDO audio filter to help this. If anyone needs more details on this setup please feel free to contact me.

Sincerely,

Frank Cathell
(H, H2)

NEWS FROM EAST TO WEST

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by: Herb Balfour, editor Northern Observer:1750M Eastern Newsletter
91 Elgin Mills Rd. West; Richmond Hill; Ontario; L4C4M1; Canada

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Activity and interest are really picking up! LF beacons are getting back on the air with the prime season upon us: (QYV)Bob Sethman, PA.(Nov. 1: 189.210); (VE3OHH)H.D. Balfour, ONT.(testing: 190.400); (VE3OBE)Bill DeCarle, ONT.(testing: 179.624); (DCH)Dave Holland, MD.(Oct.: 187.500); (9HDQ/ZMK)Dave Johnston, IND.(now in optimal winter mode: 188.470/179.500); (MOO)Norm Harbison,NJ.(new frequency:187.750).

Of particular note is the rapid growth in MF experimental beacons: ONT:OHH; NJ:NH/KEN; SC:ABC; OH:YOR. Testing: TN:XMGR; PA:QYV; N.Y; CT; N.H. DO NOT FORGET AT LEAST FIVE (5) OTHERS IN CA.!

Unidentified beacon MS (186.850-187.800) reported by Dave Raney(UPN),OH; and Keith Olson, WA.

KRY(175.388)Joe Saloka, Chardon,OH has ben the most frequently reported beacon heard in the East so far this season.

The NORTHERN OBSERVER is also listing (in addition to LF) MF; VLF and ULF beacons (experimental). We include members' HF beacons, as well. Columns (such as Dave Johnson's "BELLYDRAGGIN" (F), Los Banos, CA.) and articles (Rick Wright, 1SUN) on VLF/ULF are regular inclusions. Equipment reviews; alternate transmission modes (Bill DeCarle, VE3OBE) also appear. A continuing project to list other clubs, newsletters, sources, resources average 1-2 pgs. per issue.

Our focus is STILL 1750M, but not so tight as to exclude other areas not embraced in other forums.

A Navy test project, SPAWAR from MD/VA has ben delayed, but starts now at 185.1 khz, sending slow CW: "NWA: TEST" and a code letter/#. TNX to C and EK for tips/contacts.

Posible winter tests here in ONT include a combination radio navigation beacon and private experimental beacon from a marine location!

Net activity: evenings, particularly SUN. (E.S.T.): 1983.5 khz.

Sincere gratitude is expressed to EK; MEL; W86EER; F; for their extreme support of this "eastern" newsletter project!(presently at #4)

That's all for this first installment of Jim and my own exchanges;

Oct. 20/88. Best 73's from both the N-O and OHH...

IMPULSE NOISE AND LOW FREQUENCY RECEIVERS

During the summer months the 1750 meter band is next to useless due to thunderstorm QRN, which can easily exceed 60 db above the winter noise floor. Similarly, impulse spikes from SCR-based lamp dimmer switches can completely block reception on the LF band. Both of these nuisances create brief but very large dynamic range excursions, easily saturating most receivers. They are essentially identical in quality to pulse-type jamming methods (ECM), and a careful look at anti-jamming methods (ECCM) for coping with pulse jamming is warranted. One might think that this subject is enshrouded in military secrecy; however, fairly good unclassified sources are available, and much can be learned from the older literature (1).

To illustrate the idea of pulse jamming, consider the following two diagrams. In the first case, impulses of 1 msec duration and recurring at 20 msec intervals are applied to an amplifier with a bandpass of 5000 Hz. The time constant of this amplifier is approximately the reciprocal of the bandpass, or about 0.2 msec, and since this is shorter than the impulse interval, the impulse waveform is recorded fairly faithfully. The amplifier spends most of its time in a quiescent state. Contrast this with case two, where the applied waveform is identical to the first case but the amplifier bandpass is reduced to 100 Hz. The amplifier time constant is now about 10 msec, and the ringing induced by one impulse is still present when the next pulse arrives. The amplifier is never quiescent and certainly unable to deal with weak signals. Large impulses also adversely affect the AGC, even when the bandwidth is broad. Railing ECM uses these concepts, where pulse recurrent frequency is closely matched to the probable receiver bandpass in an attempt to keep the receiver continually ringing.

Using an oscilloscope and a regenerative preamplifier (2) I have actually observed the above effects for QRN and SCR dimmer noise in a 100 Hz bandpass receiver, and I can confirm that they are very real. SCR spikes are narrower than 1 msec and spaced about 8 msec apart (2 per 60 Hz cycle). As expected, the ringing is even worse than in case two. Lightning discharges are multiple strobes. The individual impulses are about 1 msec wide, and the interval between strobes is in the range of 40 to 80 msec (3). These bursts can come in waves or be almost continuous, so a narrowband receiver is effectively blocked when this is happening. It is a familiar experience! But we all know that a LowFER receiver needs very narrowband (selective) qualities in addition to excellent sensitivity, and there is where we end up sacrificing the summer months.

ECCM methods for rescuing signals from deliberate interference are based on characteristics of the signals which distinguish them from the interference. The basic discrimination factors are spatial, frequency, amplitude, signal coding and time (1); these factors never change and are always inherent in electromagnetic communications. As an example, a radar or communication system which escapes ECM by frequency hopping is discriminating in the frequency domain. Similarly, a LowFER receiver working through a directional loop antenna to null an aggravating interference is discriminating in the spatial domain. For our purposes, most measures for coping with impulse noise are based on amplitude and time discrimination.

From the above it is a cardinal rule that large amplitude pulses must never be applied to a narrowband amplifier. This suggests RF

processing ahead of the frequency-selective stage. One such method involves wide bandwidth RF amplification followed by amplitude limiting (1). For dealing with the impulse problems of LF, "wideband" is just a good audio bandwidth, and something in the neighborhood of 4,000 Hz will work. This bandwidth can be based on the Q of the preamplifier (2).

I have built and tested the front-end limiter circuit labeled "A", which contains four stages of modular amplifiers, and it works if the preamplifier has appropriate gain and impedance matching so that its own noise supercedes the limiter's front-end noise. This RF processor goes between the preamplifier and the receiver. Also note that the last amplifier is DC coupled to the crossed diodes (which clip at about 0.7 V) - that is not a mistake in the figure. The limiter circuit and its 9V battery must be enclosed in a well-shielded box, and the stages must also be shielded from each other; otherwise it will oscillate from feedback. The circuit has close to unity gain when the gain control is set full-scale.

With the limiter in place, an increase in gain (= limit level), starting from the zero point, causes the impulse noise to increase to a plateau (where clipping sets in). Beyond this point further gain increases improve the signal relative to the impulse noise, and the effect can be dramatic. For example, I tried locating the preamplifier and 5 ft whip antenna about 10 ft away from a dimmer switch. The result with just the preamplifier was a horrible buzz, and it was impossible to detect strong GWEN signals. With the limiter in place, the situation became reversed. The GWEN signals were crisp and clear, and the dimmer buzz was hardly a bother.

The main weakness of front-end limiters is their susceptibility to capture by a strong CW signal in the bandpass. For example, when I turned on a TV in an adjoining room, about 15 ft away, the harmonics of the horizontal frequency proved to be more than competetive with GWEN signals. Turning up the gain virtually quenched the dimmer noise, but with the TV harmonics now riding the rails, the relatively weaker GWEN signals were no longer heard!

The front-end limiter works much better at a site relatively free of strong PLCs and TV harmonics. On the afternoons of August 16 and 21, 1988 I reduced 1SUN's power to 100 mW and went to a location of this type 2 miles SW of the transmitter. These were good tests since T-storms were nearby and producing a lot of QRN (especially on the 21st). With just a preamplifier and a Sony ICF-2002 (the worst dynamic range on the market!), I could actually hear the LowFER, about 2% to 5% of the time, through the hashed-up mess! But with the limiter in place and the gain set full-scale, the LowFER became comfortably and continuously readable. Problems occur here when a strong GWEN signal comes blasting in, blocking the receiver against any weaker signals. As in most things, the front-end limiter is a kind of negotiation between several factors, but it is a distinct improvement, especially at a location which presents mostly impulse noise.

The circuit labeled "B" is an attempt to get around CW capture problems inherent in the front end limiter. It acts on the output of the limiter, only with the gain set so that the strongest signals are about one third the amplitude of the limit level (i.e., about 0.2 volts at the clipper). Under these conditions the impulse noise pulses stand out high enough that the threshold amplifier can create good leading edge triggers for the 4528 gate generator. Gates Q and NOT-Q allow a fast selection between the limiter output and an equivalent white noise source. In some preliminary tests I found that just blanking the receiver during impulses was poorer than gating white noise to fill the gaps. In fact, I could make the dimmer noise go almost fully quiet by the latter method. For want of a better name, I call the circuit "pulse interference noise gating" (PING), and it is still only a half-baked idea. It will probably work better with a 10 microsecond delay in the signal path and after the threshold stage, so that the leading edge of the pulse is fully blanked (I need a 10 microsecond delay line donor!).

The whole point of doing these sorts of things is to reduce impulse noise to levels low enough not to compromise a following narrowband stage. Then it might be possible to achieve the kind of frequency discrimination so necessary for detecting weak LowFER signals.

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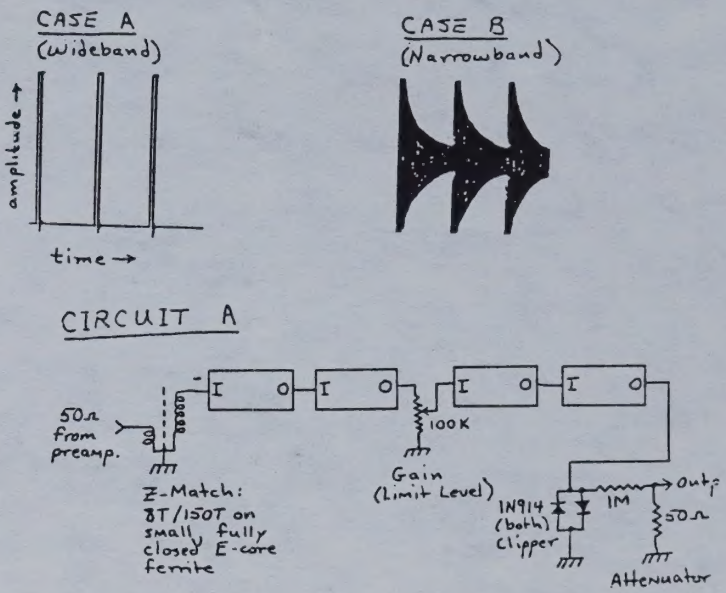
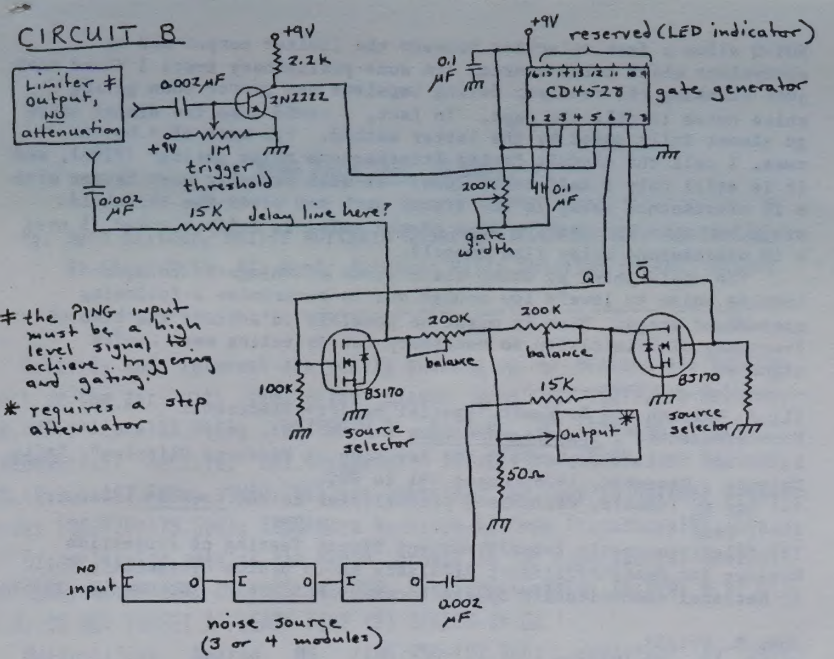
(1) J. Holahan and B. Kovit,"Special Report: Electronic Countermeasures", Space/Aeronautics , June 1962, pages 11 and 14; J. R. Davis, "ELF Atmospheric Noise Excision by Wideband Clipping", Radio Science , December, 1976, pages 991 to 999.
(2) See my tunable, variable-Q preamplifier in the Lowdown , January 1988, page 44.
(3) "Electromagnetic Pulse/Transient Threat Testing of Protection Devices for Amateur/Military Affiliate Radio System Equipment", Vol. I, National Communication System Document NCS TIB 85-10, October 1985.

John R. Wright
KA5YWH and 1SUN LowFER





POSTMORTEM

The Cat Heard Round the World

When Charles Bray arrived for work at Princeton University's Psychological Laboratory, he was hoping for just a bit of progress in that day's test of a cat's hearing. He checked in at the operating room, found colleague Glen Wever at work, then followed an electrical cable to a soundproof room several doors down the hall.

The setup, still untried, was simple. The cable ran from the cat to an amplifier to which they had wired a telephone receiver. While Wever played electronic tones into the cat's ear, Bray would listen for activity in its auditory nerve. With any luck, they'd all be in for a session of tweets, beeps, and buzzes.

At the other end Wever busied himself with the anesthetized cat, carefully threading a wire toward the bony, snail-shaped organ, or cochlea, at the end of the auditory canal. When the wire touched the cat's auditory nerve, Wever cleared his throat and spoke. He was not quite ready for what came next. He heard running in the hall, then Bray burst in. "Glen, I can hear you! I can *understand* you!" Bray exclaimed. "Your voice is coming through the cat!"

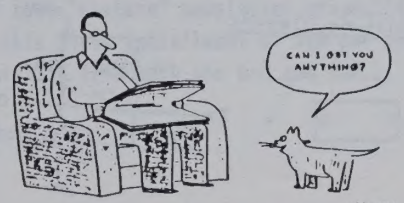
"Speech was transmitted with great fidelity," Wever later wrote. "Simple commands, counting, and the like were easily received. Indeed, under good conditions the system was employed as a means of communication between operating and soundproof rooms." Wever later recorded one of his demonstrations by speaking to a cat wired to a tape recorder.

Wever's work, performed in 1927, was the first to show that sound waves entering the outer ear are transformed in the cochlea to electrical currents, which then pulse down the auditory nerve to the brain.

The news aroused the world's hearing researchers, who quarreled for almost 40 years before agreeing that the Wever-Bray effect was the combined response of the cochlea's hair cells—the 24,000 tiny receivers that turn sound's physical motion into electricity.

These experiments launched the modern study of human hearing, including the diagnosis of deafness. Using electrodes linked to computers, physicians can locate problems in the hair cells or nerves. The technique, called electrocochleography, came directly from Wever's cat.

HIPPOCRATES January/February 1988



NEW, IMPROVED CAT

(courtesy NEW YORKER)

TRANSCONTINENTAL LOWFERISMO??

David E. Johnson
Fisher Research Lab
Los Banos, Calif.

The project outlined below is well within the capabilities of at least several members of the Longwave club, and is probably simpler than some of the installations that have already been built.

TRANSMITTER: crystal controlled, FSK modulated with repeating ident at 1 baud rate. Carrier is suppressed: keying selects upper or lower sideband frequency offset, preferably plus and minus 60 Hz. The 1 baud clock is manually sync'd to the minute marker on WWV, and the ident is a submultiple of 60 seconds. (My present "F" beacon is almost like this.)

RECEIVER: crystal controlled, crystal frequency matched to the transmitter crystal frequency within 2 ppm. Mixer is a direct conversion phasing type which produces two IF signals, a 60 Hz upper sideband and 60 Hz lower sideband. If the receiver incorporates a noise blanker it should be located in the RF stages. The IF filters should be multiple stages of biquad filters having relatively linear delay characteristics and a bandwidth of about 2 Hz. Each IF filter is followed by a full wave AM demodulator. The output of the lower sideband demodulator is subtracted from the output of the upper sideband demodulator: this tends to balance noise out to zero. Signal in the upper channel produces a positive voltage; signal in the lower channel produces a negative voltage. This voltage drives an integrator which is reset at the beginning of each WWV second and is sampled at the end of each WWV second. (Actually, the clock that operates the integrator should be delayed a fraction of a second to make up for delay in the IF stages.) The samples are accumulated in a memory and after a few minutes or so the samples are summed up in their respective time slots to produce the ident of the transmitted signal. Accumulation and summing of samples would probably be done in a computer- which might also produce the integrator timing signals.

This system should provide signal detection at a distance many times what is customary using slow Morse CW and audio detection through narrowband audio filters using headphones. The FSK gives a 3 db improvement. The 2 Hz bandwidth gives a 13 db improvement over a 40 Hz bandwidth. The synchronous clocked integrator together with the accumulate-and-sum routine probably provide at least another 10-15 db of performance (theoretically much more if you have time to accumulate forever, but practical considerations put severe restrictions on how much the accumulate-and-sum routine can buy you.) Totalling the decibels, we have 26-31 db of improvement. If the transmitted wave signal strength is inversely proportional to distance, this system should provide signal detection at a distance roughly 20 times what can be achieved by conventional longwave practice. Or, looking at it another way, it should allow you to transmit and receive signals over the kind of distance that would be possible with conventional technique but running 500-1,000 watts in the transmitter. In short, the system should make transcontinental and even transoceanic contact possible--if not on a regular basis, at least once in a while when radio propagation conditions are good.